INTERNATIONAL
TECHNOLOGY
CORPORATION

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Project No. 301679

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Support Documentation: Estimation of Uranium-235 Surface Soil Concentrations Based on Mass Unrecovered at the BORAX-I Burial Grounds

Dear Jean:

IT is pleased to submit the attached documentation to support estimation of possible uranium (U)-235 surface soil concentrations and activities based on the mass of U-235 unrecovered at the BORAX-I burial ground. This information was developed as a result of public comment on the SL-1 and BORAX-I proposed plan regarding the possibility for soil washing to recover the U-235 remaining at the site. Response to the comment involved estimation of the U-235 concentration in mg/kg. This idea was taken one step further to provide additional information for the uncertainty discussion in Section 6: the concentration of U-235 in mg/kg was converted to pCi/g for comparison to the soil sampling analytical data. The calc briefs detailing the estimates are attached.

Two different soil volumes were used in the estimates to provide a better understanding of the possible range of concentrations at the site. The first volume was based on the entire gravel-covered area (84,000 ft^2) and a depth of one foot. The second volume (also one foot deep) was restricted to the areas found with radiological fields above 20 μR/hr in surveys conducted in 1978 (14,700 ft^2). A soil density of 1.5 g/cm^3 was assumed, consistent with the density used in the baseline risk assessment for BORAX-I. Results of the calculations are presented in Table 1.

Table 1. Estimated U-235 surface soil concentrations and activities.

Soil Volume (cubic feet)	Concentration (mg/kg)	Activity (pCi/g)
84,000	1	2
14,700	6	13

If you have any questions, please call me at 505-662-1236.

Respectfully submitted,

IT CORPORATION

Richard Filemyr
Project Manager

attachments

cc: Doug Vetter, IT-Albuquerque
Larry Hull, IT-Idaho Falls
Central File 301679

Attachment 1

Calc Brief: BORAX-I Surface Soil Uranium Concentration

BORAX-I Surface Soil
Uranium Concentration

Purpose: To determine the concentration of uranium in the surface soils in mg/kg.

Assumptions: The soils contain 3.7 kg of uranium evenly distributed throughout two different volumes of surface soil: an area of 84,000 ft^2 to a depth of 1 ft, and 14,700 ft^2 to a depth of one foot (see attached figure).

The soil density is 1.5 g/cm^3.

Calculation: 84,000 ft^3 volume

mg of uranium:

$$3.7 \text{ kg} \left(\frac{10^6 \text{ mg}}{\text{kg}}\right) = 3.7 \times 10^6 \text{ mg.}$$

kg of soil:

$$84{,}000 \text{ ft}^3 \left(\frac{12 \text{ in}}{\text{ft}}\right)^3 \left(\frac{16.387 \text{ cm}^3}{\text{in}^3}\right) = 2{,}378{,}605{,}824 \text{ cm}^3$$

$$1.5 \text{ g/cm}^3 \ (2{,}378{,}605{,}824 \text{ cm}^3) = 3{,}567{,}908{,}736 \text{ g}$$
$$= 3{,}567{,}908.736 \text{ kg}$$

uranium concentration based on 84,000 ft^3:

$$\text{concentration} = \frac{3.7 \times 10^6 \text{ mg}}{3{,}567{,}908.736 \text{ kg}} = 1.037 \text{ mg/kg}$$

BORAX-I Surface Soil
Uranium Concentration
Continued

Calculation: 14,700 ft^3 volume

kg of soil:

$$14{,}700\ ft^3 \left(\frac{12\ in}{ft}\right)^3 \left(\frac{16.387\ cm^3}{in^3}\right) = 416{,}256{,}019.2\ cm^3$$

$$1.5\ g/cm^3\ (416{,}256{,}019.2\ cm^3) = 624{,}384{,}028.8\ g$$
$$= 624{,}384.03\ kg$$

uranium concentration based on 14,700 ft^3:

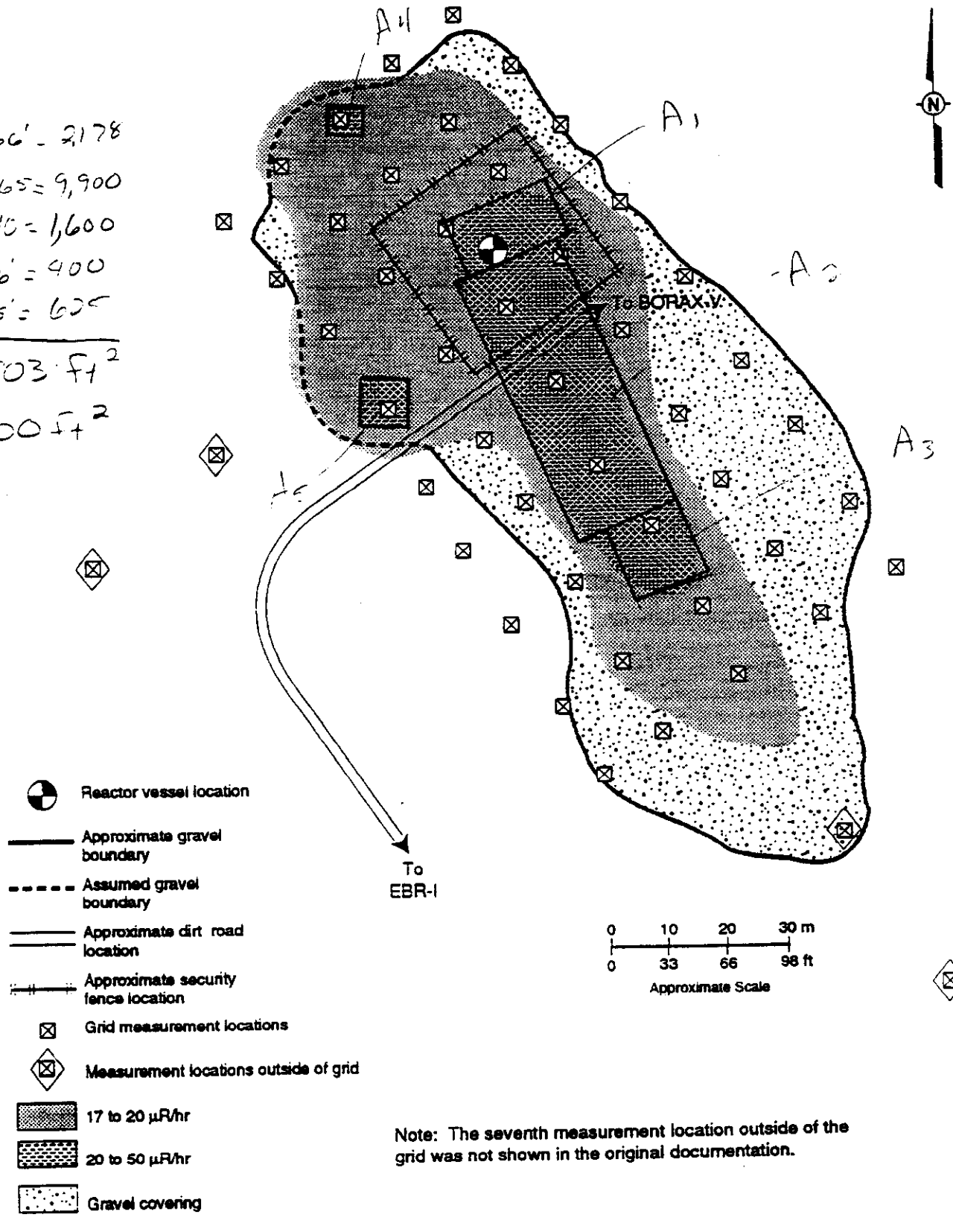
$$\text{concentration} = \frac{3.7 \times 10^6\ mg}{624{,}384.03\ kg} = 5.9\ mg/kg$$

301679 A6

$A_1 \cong 33' \times 66' = 2178$
$A_2 \cong 10' \times 165 = 9,900$
$A_3 \cong 40 \times 40 = 1,600$
$A_4 \cong 25' \times 16' = 400$
$A_5 \cong 75' \times 25' = 625$

$= 14,703 \text{ ft}^2$

$\cong 14,700 \text{ ft}^2$



Note: The seventh measurement location outside of the grid was not shown in the original documentation.

Exposure rate isoplethic map for the BORAX-I reactor area.

Attachment 2

Calc Brief: BORAX-I Surface Soil Uranium Activity

BORAX-I Surface Soil
Uranium Activity

Purpose: To determine the uranium activities in pCi/g based on the concentrations in mg/kg as determined in Attachment 1.

Reference: *Radiological Health Handbook*, Revised Edition, January 1970 (see attached).

Given: The specific activity of U-235 is 2.14×10^6 pCi/g (*Radiological Health Handbook*, see attached).

Calculation: Based on U-235 soil concentration of 1.037 mg/kg

$$\left(\frac{1.037\ mg_{(U)}}{kg_{(soil)}}\right)\left(\frac{1\ g_{(U)}}{1{,}000\ mg_{(U)}}\right)\left(\frac{1\ kg_{(soil)}}{1{,}000\ g_{(soil)}}\right)(2.14 \times 10^6\ pCi/g_{(U)})$$

$$= 2.22\ pCi/g$$

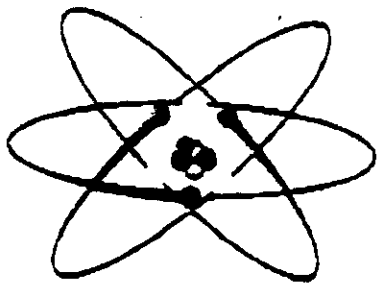
Calculation: Based on U-235 soil concentration of 5.9 mg/kg

$$\left(\frac{5.9\ mg_{(U)}}{kg_{(soil)}}\right)\left(\frac{1\ g_{(U)}}{1{,}000\ mg_{(U)}}\right)\left(\frac{1\ kg_{(soil)}}{1{,}000\ g_{(soil)}}\right)(2.14 \times 10^6\ pCi/g_{(U)})$$

$$= 12.6\ pCi/g.$$

RADIOLOGICAL HEALTH HANDBOOK

Compiled and edited
by the
Bureau of Radiological Health
and the
Training Institute
Environmental Control Administration



Revised Edition
January 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Rockville, Maryland 20852

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $4.00

SPECIFIC ACTIVITY

Radionuclide	Half-Life	Curies per gram	Radionuclide	Half-Life	Curies per gram
Hydrogen-3	12.3y	9.64×10^{3}	Molybdenum-99	67h	4.72×10^{5}
Carbon-14	5730y	4.46	Technetium-99m	6.0h	5.28×10^{8}
Nitrogen-16	7.2s	9.79×10^{10}	Ruthenium-106	367d	3.36×10^{3}
Sodium-22	2.60y	6.25×10^{3}	Iodine-125	60d	1.74×10^{4}
Sodium-24	15.0h	8.71×10^{6}	Iodine-130	12.4h	1.94×10^{6}
Phosphorus-32	14.3d	2.85×10^{5}	Iodine-131	8.05d	1.24×10^{5}
Sulfur-35	88d	4.24×10^{4}	Barium-133	7.2y	374
Chlorine-36	3.1×10^{5}y	3.21×10^{-2}	Cesium-134	2.05y	1.30×10^{3}
Argon-41	1.83h	4.18×10^{7}	Cesium-137	30.0y	87.0
Potassium-42	12.4h	6.02×10^{6}	Barium-140	12.8d	7.29×10^{4}
Calcium-45	165d	1.76×10^{4}	Lanthanum-140	40.22h	5.57×10^{5}
Chromium-51	27.8d	9.21×10^{4}	Cerium-141	33d	2.81×10^{4}
Manganese-54	303d	7.98×10^{3}	Cerium-144	284d	3.19×10^{3}
Iron-55	2.6y	2.50×10^{3}	Praseodymium-144	17.3m	7.55×10^{7}
Manganese-56	2.576h	2.17×10^{7}	Promethium-147	2.62y	929
Cobalt-57	270d	8.48×10^{3}	Tantalum-182	115d	6.24×10^{3}
Iron-59	45d	4.92×10^{4}	Tungsten-185	75d	9.41×10^{3}
Nickel-59	8×10^{4}y	7.58×10^{-2}	Iridium-192	74.2d	9.17×10^{3}
Cobalt-60	5.26y	1.13×10^{3}	Gold-198	64.8h	2.44×10^{5}
Nickel-63	92y	61.7	Gold-199	75.6h	2.08×10^{5}
Copper-64	12.8h	3.83×10^{5}	Mercury-203	46.9d	1.37×10^{4}
Zinc-65	245d	8.20×10^{3}	Thallium-204	3.8y	462
Gallium-72	14.1h	3.09×10^{6}	Polonium-210	138.4d	4.49×10^{3}
Arsenic-76	26.5h	1.56×10^{6}	Polonium-212	304ns	1.75×10^{17}
Bromine-82	35.34h	1.08×10^{6}	Radium-226	1602y	0.988
Rubidium-86	18.66d	8.14×10^{4}	Thorium-232	1.41×10^{10}y	1.09×10^{-7}
Strontium-89	52d	2.82×10^{4}	Uranium-233	1.62×10^{5}y	9.48×10^{-3}
Strontium-90	28.1y	141	Thorium-234	24.1d	2.32×10^{4}
Yttrium-90	64h	5.44×10^{5}	Uranium-234	7.1×10^{8}y	2.14×10^{-4}
Yttrium-91	58.8d	2.44×10^{4}	Uranium-238	4.51×10^{9}y	3.33×10^{-7}
			Plutonium-239	2.44×10^{4}y	6.13×10^{-2}